

An NSF Nanoscale Science and Engineering Center



**Center for  
Biological and  
Environmental  
Nanotechnology**

## Nanotechnology Education in an NSF Center

Prof. Vicki Colvin, Director

Prof. Rick Smalley, Founding Director

**Dr. Kristen Kulinowski, Executive Director**

**Ms. Suzanne Lamminen, NanoKids Producer**



<http://www.rice.edu/cben>

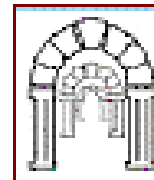




# CBEN Information

- Inception
  - September 2001 (2 years)
- General Activities
  - Research
  - **Educational programs**
  - Industry-related programs
- Financial Scope
  - \$11.8 million from NSF over five years
  - \$5.3 million from Rice over five years
  - Competitive renewal for a second five years
- Span of Activities
  - 10 Departments
  - 25 Directly Funded PIs

- Shared Equipment
  - Purchases of new equipment
  - Maintenance of old equipment
  - Technical staff
- **Outreach Partners**



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School of  
Continuing Studies



Baker Institute for  
Public Policy



# The Mission of CBEN

Our mission is to create sustainable nanotechnologies that improve human health and the environment.

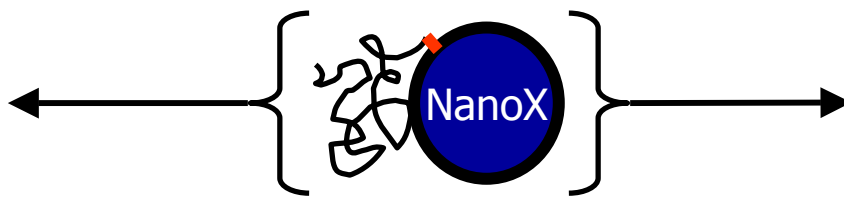
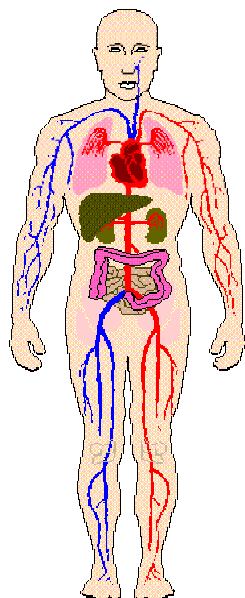
We do this by:

- Exploration of the interface between nanostructures and real-world environments (e.g. the wet/dry interface).
- Engineering systems that use nanotechnology to solve biomedical and environmental problems.
- Nurturing the development of viable nanotechnologies.
- Training future nanotechnologists.



# CBEN's Organizing Principle

## The Wet/Dry Interface



Theme 1:  
Nanoscience  
(Colvin)



Theme 2:  
NanoBioengineering  
(West)

Theme 3:  
NanoEnvironmental Engineering  
(Hughes)

## Applications *and* Implications



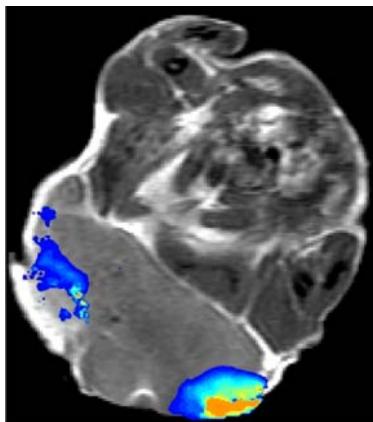
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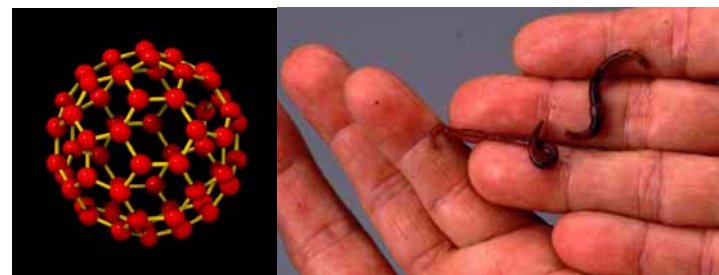
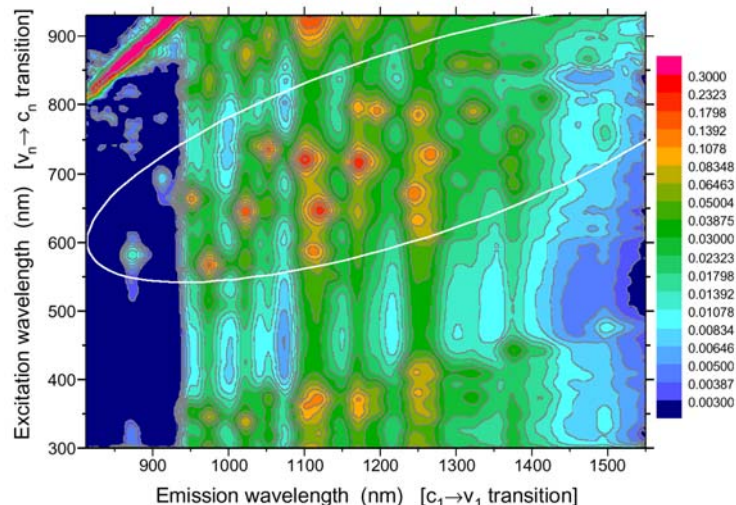
# Research Highlights



**Nanoshell-heated  
cancer tissue**

- Cancer photothermal therapy
- Carbon nanotubes for bioimaging
- Fullerene bioaccumulation

## **Nanotube fluorescence**

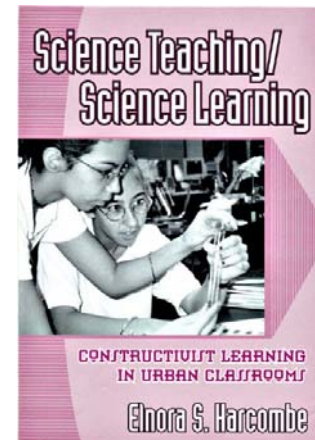
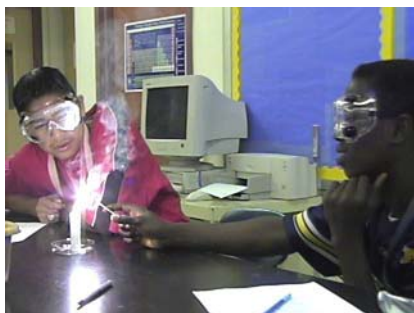


**Earthworm bioaccumulation of  
fullerenes** (right-hand image from  
<http://www.sarep.ucdavis.edu/worms/image5.htm>)



# CBEN

Center for Biological and Environmental Nanotechnology



## Educational Programs

### Developing the Nanotechnologists of the Future



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# Do Your Homework...

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- Start with careful reading of NSF program goals
- Look at descriptions of successful programs from previous calls
- Formulate a mission statement
  - What is your “central question”?
- Look within your own institution for precedent, partnerships, leverage, inspiration





# ..Then Design a Program

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## Essential Features

- Meets NSF program goals
- Addresses your mission statement
- Leverages existing resources
- Does something new that's been done before





# The Innovation See-Saw

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**Proven Program**

**Innovative Idea**

- **Established track record**
- **Concept refined over time**
- **Good assessment data**
- **Received external recognition**

- **Never been done**
- **High risk**
- **Little to no assessment**
- **Largely unknown, untested**



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# CBEN's Educational Outreach Goal

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To cultivate a future workforce experienced with using nanoscience and nanoengineering to solve problems in biological and environmental engineering



# Approach

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**Community**



**Faculty**

**Graduate/Post-Doc**

**Undergraduate**

**High School**

**Middle School**

- Need to begin developing workforce now
  - Graduate and post-doc training
- Start training workforce of future
  - Target many educational levels
- Provide a continuum of programs



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# List of Programs

See Suzanne Lamminen for more info

## ■ High School

1. 9th-grade Teacher Training Sequence
  - Spring Content Course
  - Summer Internship
  - Model Science Lab II
2. Teacher Training Workshop
3. High School Student Summer Academy

## ■ Middle School

4. NanoKids™ Curriculum Development

## ■ Undergraduate

5. Curriculum Development

## ■ Graduate/Post-doc

6. Curriculum Development
7. Entrepreneurship Education

## ■ Community

8. Public Courses on Nanotechnology

## ■ New for 2002-2003

9. Grad student meetings
10. NanoKids training workshop
11. Nanotechnology Research Experience for Undergraduates

## ■ New for 2003-2004 (proposed)

1. Workshop on nano in Advanced Placement courses
2. Science Policy and Ethics course



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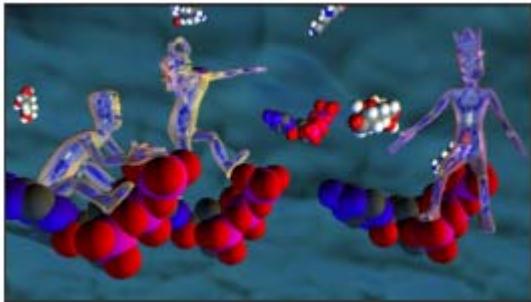




# Leveraging Existing Programs: Two Models

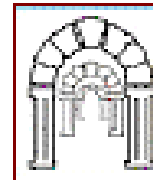
## NanoKids™

- Started with low level of private support by Prof. Jim Tour and Suzanne Lamminen
- CBEN provides resources for staff and beta-testing
- SGER grant secured

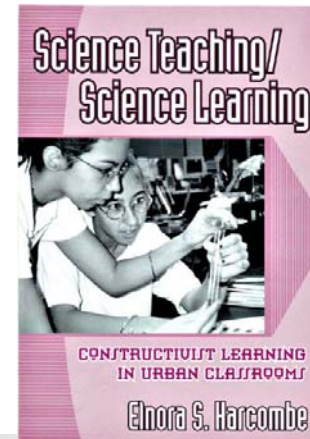


## Teacher-training Program

- Based on pre-existing middle school program started by Center for Education Prof. Elnora Harcombe
- Pre-existing program picked up by HISD



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# CBEN's Impact on Teacher Training

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## Pre-CBEN

- Year-long sabbatical residency
- **Middle school**
  - 55,000 students impacted in 12 yrs
  - 97% of resident teachers remain in education after 12 yrs
    - Annual HISD turnover rate is 1 in 7
  - Increased student achievement in residents' classroom

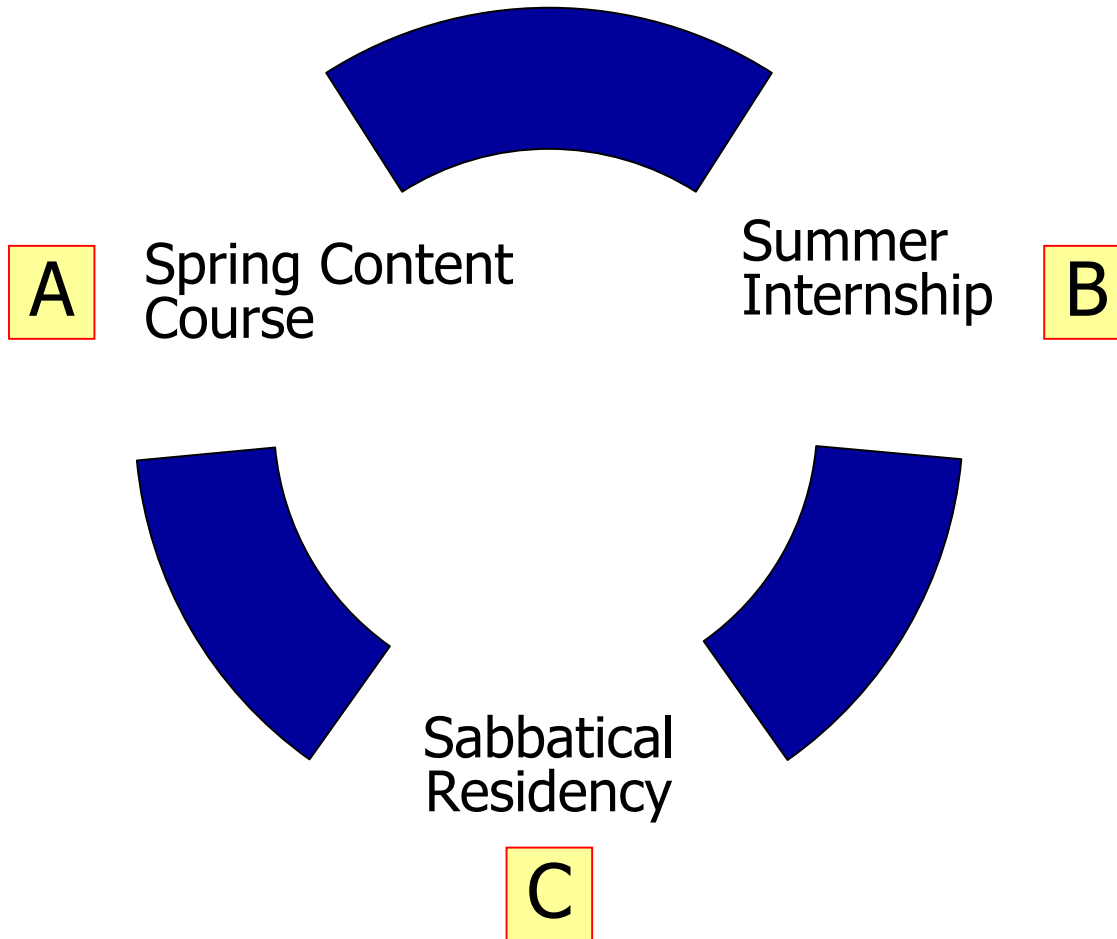
## CBEN

- Year-long sabbatical residency
- **High school**
- **Spring content course**
- **Summer research internship**
- **Increased scientific content**
- **Links between nanotech research and TX state curriculum**



# Teacher Training

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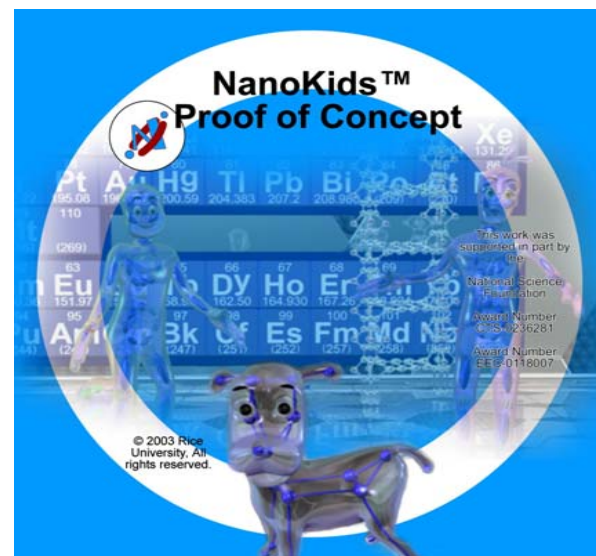




# NanoKids™ Progress Update

- Completed 20-min proof-of-concept animation DVD
- Developed
  - Interactive Workbook
  - Interactive Teacher's guide
  - Interactive Parent's guide
  - Support website
- Approved for testing in 13 HISD middle schools Sept 2003
  - Linked to Texas Assessment of Knowledge and Skills (TAKS) objectives
- Formative evaluation underway

**CBEN-supported workshop for teachers to be held June 2003**



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# ACS Symposium

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## **Nanotechnology and Education: A State of the Art Symposium**

**227th National Meeting of the American Chemical Society  
Division of Chemical Education  
Anaheim, CA  
March 28-April 1, 2004**

### **Organizers:**

Wayne E. Jones Jr., Department of Chemistry, SUNY Binghamton  
[wjones@binghamton.edu](mailto:wjones@binghamton.edu)

Kristen M. Kulinowski, Department of Chemistry/CBEN, Rice University  
[kk@rice.edu](mailto:kk@rice.edu)

**Submit your abstract NOW at <http://oasys.acs.org/oasys.htm>**



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# Acknowledgements

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- Prof. Jim Tour
- Prof. Vicki Colvin
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